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Field Guide for Managing Rush Skeletonweed in the Southwest

Forest Service

Southwestern Region

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Rush skeletonweed (*Chondrilla juncea* L.)

Sunflower family (Asteraceae), Lactuceae tribe (Cichorieae)

Rush skeletonweed is an invasive plant in the Southwest that has been listed as a noxious weed in Arizona. This field guide serves as the U.S. Forest Service's recommendations for management of rush skeletonweed in forests, woodlands, and rangelands associated with its Southwestern Region. The Southwestern Region covers Arizona and New Mexico, which together have 11 national forests. The Region also includes four national grasslands located in northeastern New Mexico, western Oklahoma, and the Texas panhandle.

Description

Rush skeletonweed (synonyms: skeletonweed, hogbite, gum succory, devil's grass, naked weed) is a wiry, introduced perennial with great potential to spread rapidly and form dense infestations given favorable conditions. It originated in Eurasia and is now widespread in western states including Washington, Oregon, Idaho, Montana, and California. An isolated, yet expanding population has been found in the Grand Canyon National Park in Arizona. Thus far, three distinct genotypes have been identified with each genotype differing slightly in the appearance of the rosette leaves and branching. In the rosette stage, rush skeletonweed resembles common dandelion (Taraxacum officinale) and chicory (Cichorium intybus L.). After bolting, rush skeletonweed can be distinguished by its brown, downward-pointing hairs near the base of the flowering stem.

Growth Characteristics

- Long-lived perennial herbaceous plant; mimics a biennial (overwinters as a rosette).
- Rosette base with 2 to 5 inch hairless reddish-brown leaves with purplish incised margins and lobes pointing backward toward the leaf base; lobes are so deep the leaf looks nearly pinnate.
- Produces bright green or yellowish, wiry, erectly branching flowering stems in spring; stem has few narrow, linear leaves with entire margins and brown, downward-pointing hairs at its base. Flowering stem is persistent and becomes increasingly tough as it matures; 16 to 48 inches tall.
- Exudes a white milky substance from cut, broken, or damaged stem, leaf, and root surfaces.
- Small, bright yellow flowers from May until first frost; flowers are located on the end of the branch (terminal) or between the branch and stem (axillary). The flowers may be directly attached to the branch (sessile) or be on short stalks (pedicelled); flowers may also be found in clusters of 2 to 5. Instead of the disk and ray flowers common to other species in the Asteraceae family, rush skeletonweed has only one type of flower (ligulate). Heads have 9 to 12 strap-shaped flowers; each flower has 5 fused petals that have a toothed appearance at the tip.
- Deep and stout taproot; rapidly grows overwinter to a depth of 3 to 7 feet.
- Reproduces mainly vegetatively via adventitious buds near the top of the taproot; lateral roots near surface can become rhizome like and also have root buds; dense patches of cloned plants may form in response to damage. Seed is also asexually produced (15,000 to 20,000 seeds per plant). Seeds are oblong, ribbed achenes with a pappus of numerous soft bristles. Depending on soil conditions, seeds may remain viable from 6 months to longer than 8 years. Seed quickly germinates in response to available moisture; seedling mortality rate is high should extremely dry conditions occur immediately after establishment.

Ecology

Impacts/threats

The potential for rapid spread of rush skeletonweed is high once it is introduced to an area with favorable growth conditions; it is difficult to eradicate once established. Persistent flower stems are so tough they can hamper harvest machinery and the weed causes lost production in wheat fields; diminishes preferred rangeland forage; and reduces plant and animal diversity.

Location

Rush skeletonweed adapts to a wide range of climate zones and environmental conditions. Generally, it prefers well-drained sand or gravel and does not fare well in waterlogged or heavy clay soils. It prefers areas with 10 to 40 inches of precipitation, preferably with moisture available at the onset of the cool season and in the spring. Rush skeletonweed is limited by the amount of calcium and phosphorous available in the soil. It may invade roadsides and other transportation corridors, rotational pastures, croplands (especially grain fields), waste areas, and rangelands.

Spread

Although rush skeletonweed produces wind-dispersed seed, it spreads mainly through vegetative propagation that arises from adventitious buds. Root fragments that are only 1 to 2 centimeters in length can produce new plants even if the fragments are buried in soil to a depth of 3 feet. Seed or root fragments may be introduced into new areas via transportation corridors such as roadways and train tracks. Rush skeletonweed may also spread through transported hay that is not certified to be weed free or through attachment of propagules that adhere to the undercarriages of off-road vehicles and road maintenance equipment. The most rapid spread appears to occur at mid-elevation areas.

Invasive Features

While rush skeletonweed is capable of spreading rapidly, it does not typically invade stands of native vegetation in good condition. Drought, soil disturbance from human or animal activities, and open plant communities can increase the likelihood for invasion. Rush skeletonweed's competitiveness is believed to be related to its ability to reproduce vegetatively in response to damage such as severed roots, stems cut near the base, and fire. Once established, grasses are unlikely to outcompete rush skeletonweed for water and nutrients.

Management

Because rush skeletonweed is so difficult to remove once established, prevention along with early detection are the most cost-effective management actions against this invasive plant. When discovered, as much of the skeletonweed population should be controlled as possible. Followup treatments should then be implemented to capture new or returning plants. Typically, it is necessary to visit and re-treat areas later in the season which should be repeated for 1 or 2 years. Small or isolated populations of rush skeletonweed on otherwise healthy sites should be given high priority for treatment, followed by weeds found along transportation corridors such as along railways or roadsides. As with other perennial weeds that primarily reproduce vegetatively, a treatment option should be selected that destroys the extensive root system. The following actions should be considered when planning an overall management approach:

- Maintain healthy plant communities and the presence of ground litter to prevent or limit rush skeletonweed infestations. This may involve using improved grazing management to prevent excessive grazing and reseeding areas primarily with desirable forbs and grasses after disturbance.
- Detect, report, and map known infestations. Keep annual records of reported infestations.
- Eradicate new populations of rush skeletonweed as early as possible. New rush skeletonweed plants (younger than 5 weeks) have poorly developed roots and are easily killed when uprooted.
- Combine cultural, biological, and chemical methods for most effective rush skeletonweed control.
- Implement a monitoring and followup treatment plan for missed plants and seedlings.
- Use certified weed-free seed and hay; use pellets for horses used in back-country areas.

Table 1 summarizes some management options for controlling rush skeletonweed under various situations. Choice of individual control method(s) for rush

Table 1. Management options*

Site	Physical Methods	Cultural Methods	Biological Methods	Chemical Methods
Roadsides, fence lines, or noncrop areas	Cultivation may increase root spread and is not recommended. Repeated mowing is a suppression option along roadways although this will not kill the weed.	Avoid driving vehicles and equipment through infested areas; wash if travel through these areas is unavoidable. Educate road crews and others to identify and report infestations.	Multiple classic biological control agents are available for use alone or combined with herbicide control (see table 2 for recommendations).	Use truck- or tractor-mounted spraying equipment to broadcast treat. Wash underneath vehicle after application to prevent spread.
Rangelands, pastures, or riparian corridors	Mowing, tilling, and burning are not recommended as these practices often increase weed density. Where feasible, consider planting competitive legumes, such as alfalfa and clover.	Use certified weed-free seed and hay; use pellets for horses in back-country areas. Always evaluate the need to reseed. While grasses will not out-compete stands of established rush skeletonweed, the presence of native vegetation in good condition may deter further invasion.	Multiple classic biological control agents are available for use alone or combined with herbicide control (see table 2 for recommendations). Moderate, continuous grazing by sheep and goats can reduce rosette formation and seed production. If possible, avoid grazing when rush skeletonweed is in flower or after seed has set. Closely manage grazing to prevent overuse.	In areas difficult to access, an ATV-mounted sprayer or backpack unit may be the most practical application methods. Wash underneath vehicle after application to prevent spread.
Wilderness, other natural areas, and/or small infestations	Hand removal by pulling or digging 2 to 3 times per year for several years may aid in control. Pull when soil is moist; remove all root material; wear gloves for pulling. These methods are most effective on very small populations of newly established plants.	Use certified weed-free seed and hay; use pellets for horses in back-country areas. Post signs warning visitors to remove seeds after passing through infested areas; discourage travel through infested areas if possible.	Same as above.	Use backpack or hand-held sprayers. Broadcast spraying with ground methods may be used on thicker stands if allowed. Remove seed from clothing to prevent spread.

* Choice of a particular management option must be in compliance with existing regulations for land resource.

skeletonweed depends on the degree and density of infestation, current land use, and site conditions (accessibility, terrain, microclimate, other flora and fauna present, etc.). Another consideration is the genotype present as each may respond uniquely to different treatments. Research is currently underway to determine best management practices for each of the three genotypes. Other important considerations include treatment effectiveness, overall cost, and number of years needed to achieve control. More than one control method will likely be needed for a particular site.

Physical Control

A number of mechanical control methods for rush skeletonweed have been examined, but most have shown limited effectiveness, especially where the weed has become well established. Cultivation practices that do not eliminate the root system may lead to further spread and an increase in weed density. Always consider how mechanical control may be helpful as one component of an integrated management plan.

Manual Methods

Hand removal – Hand pulling, hoeing, or digging can be effective for smaller, isolated infestations of rush skeletonweed if repeated 2 to 3 times per year over several (3 to 10) years. Removal is easier when the soil is moist and plants are beginning to bolt (but before seed set). While it is very important to pull up all parts of the plant (especially roots), it is unlikely that all root fragments will be removed.

With the exception of plants less than 5 weeks old, most rush skeletonweed will resprout from severed roots in previously weeded areas; therefore, young plants as early as possible. It is recommended that treated areas be continually monitored (about every 2 weeks) to find and remove newly emerged weeds. Wear gloves and properly dispose of debris by burning in a very hot fire or by bagging and burying in a landfill to prevent spread.

Mechanical Methods

Tillage – Cultivation or tillage is not recommended. Shallow disking should especially be avoided since deeply growing severed roots will quickly regenerate new stems and plants.

Mowing – Mowing is generally not recommended. However, repeated mowing before seed set is sometimes used along roadways for suppression of top growth. Since rush skeletonweed has such a deep and extensive root system, mowing does not significantly impact nutrient reserves and may contribute to an increase in population density. Consider repeated mowing along roadsides in combination with herbicides and the use of biocontrol agents. Rust and mites are recommended as biocontrol agents for use in roadside settings.

Prescribed Fire

Burning is not recommended. New plants from roots are quickly produced after fire, which often leads to increased dominance by rush skeletonweed. However, fire may be used to destroy debris.

Cultural Control

Prevention, early detection, and plant removal are critical for preventing rush skeletonweed establishment. Land managers, road crews, and the local public should be educated on identification of rush skeletonweed so that they can help report all suspected infestations.

When developing a strategy for controlling rush skeletonweed, also consider complementary restoration activities (such as reseeding with native perennial plants) as a way to further limit rush skeletonweed populations. Where feasible, planting legumes such as clover and alfalfa has been shown to be an effective way to provide competition and reduce the density of rush skeletonweed.

Biological Control

Grazing

Rush skeletonweed provides some grazing value in the rosette stage, but it is avoided by most animals after it has reached the bolting stage. Livestock (including cattle, horses, sheep, and goats) and some wildlife will graze rush skeletonweed until the stem becomes tough and woody (lignified); goats will graze later into the season than other livestock. Moderate, continuous grazing by sheep or goats has been found to prevent the weed from sending up a flowering stem during the summer, thus reducing seed production. Grazing should be discouraged wherever plants with flowers are present or when seed has already set.

Classical Biological Control

Table 2 lists some potential biological control agents that can affect rush skeletonweed. Midge and mite biocontrol agents have been successfully used in combination with herbicides in rangeland settings. In Australia, biological control agents have been widely used on rush skeletonweed where the weed reportedly has become less of a problem due to use of this type of management.

Presently, five biological control agents have been released for control of rush skeletonweed in North America. These include two gall-forming mites, a midge, a rust fungus, and a root-feeding moth. Generally, it is recommended that rust be released in the spring or fall; mites in the summer; and the midge in the spring. These bio-agents will not eradicate rush skeletonweed, but they will reduce seed production and stunt the weed's competitive growth. It is very important to consult with persons familiar with use of these agents before making a release. Following the release of any biocontrol agent, patience and restricted interference are recommended. A strategy such as use of a biological agent combined with a herbicide application timed to prevent the formation of a flowering stem may also be considered. See the "Control

Strategies" section for further information.

Agents used for biological control in southwestern states should be adaptable to arid environments and local conditions. Public, tribal, and private land managers may obtain biological control agents for release directly from local offices of the USDA Animal and Plant Health Inspection Service (APHIS) when the agents are available. Other sources for biocontrol agents include private companies or locally developed insectaries. A permit must be obtained from APHIS before biological control agents can be transported across state boundaries. Regulations and permit applications (PPQ 526 permit forms) pertaining to interstate shipment of biological control agents can be found at http://www.aphis.usda.gov/ppq/permits/. Although biological control agents may be collected and released within a given state without a permit from APHIS, the state's Department of Agriculture or Agricultural Extension Service should be consulted for any regulations relating to movement of these agents inside the state.

Chemical Control

Rush skeletonweed is difficult to control with herbicides, especially after the main stem bolts and flowering has occurred. Spraying should be done in either the spring or more effectively in the fall when the weed is in the rosette stage. It is important that an aggressive, reapplication program be followed to achieve long-term success. For example, spraying in the rosette stage early in the spring and again later in the fall (preferably after the first frost) has been shown to be effective in controlling rush skeletonweed. However, spray treatments often need to be repeated for 3 years.

All herbicides recommended in table 3 may be considered for rush skeletonweed control. Selective herbicides include picloram, aminopyralid, or aminocyclopyrachlor in combination with chlorsulfuron or metsulfuron. Adding 2,4-D amine with these herbicides when spraying in the spring has provided enhanced control. When mixing the herbicide solution, add an effective surfactant as suggested on the label. Rush skeletonweed has a rubbery stem surface with few leaves, and herbicide uptake can be improved by including a methylated seed oil surfactant such as Dyne-Amic®. Each herbicide product will have different requirements and restrictions according to the label. Read and understand prior to any application. To prevent development of resistance in rush skeletonweed

Table 2. Classical biological control agents

Species	Type of Agent	Site of Attack	Impacts	Use/Considerations for Release
Aceria chondrillae	gall-forming mite	shoots; axillary and terminal buds	Highly effective for reducing seed production and killing young plants.	More effective on certain genotypes; dependent on the presence of rosettes to overwinter. Readily available; APHIS approved. Permits may be required prior to release.
Bradyrrhoa gilveolella	root-feeding moth	stem base and root; buds near root crown	Reduces plant vigor and reproductive ability; causes susceptibility to fungi in larger plants and kills young plants.	Lab reared in Idaho; approved for use in 2002. As of 2009, field establishment of this agent in the western U.S. has not yet been verified. Permits may be required prior to release.
Cystiphora schmidti	gall-forming midge	stems and leaves	Causes leaf damage when exiting from galls.	Readily available; APHIS approved. Permits may be required prior to release. Consider using this and the following two agents together for greater impact.
Puccinia chondrillina	rust fungus	seedlings; whole plant	Kills seedlings; severely stresses host plant causing stunting and desiccation.	Readily available; APHIS approved. Permits may be required prior to release. Appears to favor areas with higher overnight humidity; has done well in California.

Table 3. Herbicide recommendations

Common Chemical Name (active ingredient)	Product Example[1]	Product Example Rate per Acre (broadcast)	Backpack Sprayer Treatment Using Product Example[2]	Time of Application	Remarks
Picloram[3]	Tordon 22K	1–2 quarts; add surfactant as recommended on label.	1–3%	At rosette stage in fall or early spring. Spray mature plants after first frost in the fall.	Restricted use herbicide that is selective although persistent. May be used in combination with 2,4-D.[4] At lower rate, may also be used in combination with biocontrol agents. Wait 2 months to reseed perennial grasses.
Aminopyralid	Milestone	5–7 ounces; add surfactant as recommended on label.	5–10%	Same as above.	Residual from late fall treatment of mature plants can be effective in controlling seedling emergence in the spring. May be used in combination with 2,4-D[4]. Labeled for use up to water's edge. No grazing restrictions.
2,4-D amine[4]	multiple products available	1 gallon; add surfactant as recommended on label.	3%	At rosette stage in spring (before bolt).	2,4-D[4] by itself reduces aboveground growth but does not translocate into the extensive root system; thus, plant kill is poor. Combining this herbicide with another herbicide may increase efficacy.
Aminocyclopyrachlor + chlorsulfuron	Perspective	4.75–8 ounces; add surfactant as recommended on label.	Add 5–9 grams of dry flowable powder to 1 gallon water.	Most effective on rosettes in late fall after frost.	A selective blend of active ingredients labeled for non-crop use (includes natural areas such as wildlife management areas, wildlife habitats, recreation areas, campgrounds, trailheads, and trails). Persistent; selective for broad-leaved plants; may cause temporary injury to some grass species. May be used on public, private, and tribal lands as part of an early detection and rapid response (EDRR) in treating infestations of invasive weed species.
Aminocyclopyrachlor + metsulfuron methyl	Streamline	4.75–9.5 ounces; add surfactant as recommended on label.	Same as above.	Same as above.	Same as above.
Imazapyr	Arsenal	3–4 pints	1%	Anytime when plants are growing or in the fall after frost.	Nonselective herbicide used primarily as followup spot treatment. In addition to damage from overspray, nontarget plants may be killed or injured by root transfer of imazapyr between intertwined root systems. Direct spray or use a wipe method when desirable plants are present.

[1] Trade names for products are provided for example purposes only, and other products with the same active ingredient(s) may be available. Individual product labels should be examined for specific information and appropriate use with rush skeletonweed.

[2] Herbicide/water ratio - As an example, a 3 percent mixture for a gallon of spray water is made by adding a sufficient volume of water to 4 ounces of liquid herbicide until a volume of 1 gallon is reached (4 oz ÷ 128 oz/gal = 0.03 or 3 percent). For dry formulations, particulates should be added to sufficient water as specified by the label until the required concentration or volume of spray water is reached.

[3] Restricted use pesticide - A certified applicator's license is required for purchase and use of these pesticides.

[4] 2,4-D is a restricted use pesticide in New Mexico only.

from repeated treatments, the label should be consulted for guidelines on rotating herbicide active ingredients. Consult the registrant if you have questions or need further detail.

Herbicides may be applied by backpack sprayers, ATV or UTV sprayers, or conventional boom sprayers that are pulled or attached to a tractor or truck. Properly applied and well-timed spraying can be used in combination with biocontrol agents that are appropriate for the site. Follow an integrated approach by spraying in the spring and fall coupled with release of biocontrol agents to areas larger than an acre during the growing season. When combined, these practices have been successful in providing long-term control. In certain situations where rush skeletonweed is dense and widespread, aerial herbicide application by fixed-wing aircraft or helicopter should be considered.

Control Strategies

Planning and treatments to control rush skeletonweed should be designed to meet the needs of each specific site. Practice preventive techniques where suitable. An integrated management strategy that combines control methods as necessary should be implemented to contain, reduce, or eradicate mature rush skeletonweed populations. The following strategies should be considered to contain and reduce populations of rush skeletonweed:

- **Eradication strategy for satellite populations** – Look for isolated newly emerged rush skeletonweed plants in the spring and treat plants with herbicide. Monitor treated plants after 2 to 4 weeks to observe how plants responded to treatment; if necessary, apply herbicide to plants that did not respond to first treatment. Evaluate all treated areas in the fall and respray new growth if necessary.
- **Biocontrol–grazing–herbicide strategy for rangeland** – For large infestations in a rangeland setting, use a moderate, continuous grazing approach to maintain plants in rosette form, thus reducing seed production. Apply herbicide to rosettes in the fall that are effective in killing below ground portions. Introduce biocontrol agents or reinforce existing biocontrol populations in the season recommended for release of each particular agent. Midge agents are typically released in spring; mites in summer. Biocontrol agents can infect the plants that remain following herbicide application and further contribute to control.
- **Mowing–biocontrol–herbicide strategy for roadsides** – For a roadway setting, an example of a combined control strategy is to repeatedly mow at 2 to 3 week intervals during the growing season. Consider releasing or bolstering biocontrol populations of rust and mites. In the fall or spring, apply herbicide to rush skeletonweed growing in the rosette stage.

As discussed in the “Management” section of this guide, a high priority should be placed on controlling small isolated patches or satellite populations of rush skeletonweed growing on otherwise healthy sites. For widely spread populations, containment may be the most realistic goal. For heavily infested areas, consider combining biocontrol with other control options to prevent further spread.

Adaptive Management

A persistent, coordinated commitment over many years is required for successful control of rush skeletonweed. Therefore, realistic goals and objectives should be established to prevent rush skeletonweed infestations from spreading extensively throughout a given landscape. To improve long-term success, consider using an adaptive management strategy with the overall goal of restoring desirable plant communities. The stepwise process for adaptive management involves:

1. Assessment of the overall weed problem,
2. Establishing management goals and objectives,
3. Implementation of control strategies,
4. Monitoring the effectiveness of management actions,
5. Evaluating actual outcomes in relation to expected results, and

6. Adjusting practices as necessary.

Steps of this process should be repeated in sequence as part of a continuous learning cycle that improves management planning and strategy by learning from the outcomes of previous management actions. In general, an adaptive management strategy may be considered to be successful if:

1. Stakeholders are actively involved and remain committed to the process,
2. Monitoring and assessment are used to adjust and improve management decisions, and
3. Management goals and/or objectives for the resource are being achieved.

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Suggested Web Sites

For information on invasive species:

http://www.invasivespeciesinfo.gov/

http://www.invasive.org/weedus/index.html

For information about calibrating spray equipment:

NMSU Cooperative Extension Service Guide A-613 Sprayer Calibration at http://aces.nmsu.edu/pubs/_a/A-613.pdf

Herbicide labels online:

http://www.cdms.net/LabelsMsds/LMDefault.aspx

For more information or other field guides, contact:

USDA Forest Service
Southwestern Region
Forest Health
333 Broadway Blvd., SE
Albuquerque, NM 87102

Or visit:

http://www.fs.usda.gov/main/r3/forest-grasslandhealth/invasivespecies